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ANALYSIS OF MID-GRADE NAVAL AVIATOR RETENTION

by

Scott H. Poindexter

September 1998

Thesis Advisor:	William Krebs
Co-Thesis Advisor:	Samuel Buttrey
Second Reader:	John Schmidt

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Attrition of aviators is of major concern to the Navy because of the costs and numbers involved. The Navy currently forecasts aviator retention and attrition by extrapolating historical trends. This thesis recommends that the Navy replace the current method with two alternative statistical techniques: *logistic regression* and *classification trees*. They are recommended for two reasons. First, the proposed techniques make significantly more accurate forecasts of aviator retention than the current method. Second, the proposed techniques, unlike the current method, can identify the significant variables affecting aviator retention. Use of the proposed techniques can therefore lead to the formulation of better aviator retention policies by the Navy. These arguments are demonstrated with a case study of an existing retention database. The variables identified as most significant for aviator retention in this analysis were the geographic location of an aviator's duty station, assignment to non-flying billets, and grade. Policy implications of these findings are discussed.

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ANALYSIS OF MID-GRADE NAVAL AVIATOR RETENTION

Scott H. Poindexter
Major, United States Marine Corps
B.S., United States Naval Academy, 1984

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September 1998

Author: ______________________

Scott H. Poindexter

Approved by: ______________________

William Krebs, Thesis Advisor

____

Samuel Buttrey, Co-Advisor

____

John Schmidt, Second Reader

____

Richard Rosenthal Chairman
Department of Operations Research

ABSTRACT

Attrition of aviators is of major concern to the Navy because of the costs and numbers involved. The Navy currently forecasts aviator retention and attrition by extrapolating historical trends. This thesis recommends that the Navy replace the current method with two alternative statistical techniques: *logistic regression* and *classification trees*. They are recommended for two reasons. First, the proposed techniques make significantly more accurate forecasts of aviator retention than the current method. Second, the proposed techniques, unlike the current method, can identify the significant variables affecting aviator retention. Use of the proposed techniques can therefore lead to the formulation of better aviator retention policies by the Navy. These arguments are demonstrated with a case study of an existing retention database. The variables identified as most significant for aviator retention in this analysis were the geographic location of an aviator's duty station, assignment to non-flying billets, and grade. Policy implications of these findings are discussed.

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EXECUTIVE SUMMARY

Attrition of aviators is of major concern to the Navy because of the costs and numbers involved. A variety of different policies decisions relating to accessions and training rates, tour lengths, incentive pay and bonuses, promotion opportunities etc., are made with the intent to maximize retention of quality Naval aviators. It is critical that policy decisions be based on a sound scientific foundation. Current efforts to affect turnover among Naval aviators consist mainly of Aviation Career Incentive Pay (ACIP) and Aviation Continuation Pay (ACP).

Although there have been a number of studies investigating retention, the majority of the results pertain to civilian employees (Hulin, 1968; Porter & Steers, 1973; Mobley, 1997; Mobley, Horner & Hollingsworth, 1978; Mobley, Griffeth, Hand & Meglino, 1979; Ilgen & Klein, 1988; Steers & Mowday, 1981; Cotton & Tuttle, 1986; Ilgen & Klein, 1988; O'Reilly, 1991). The lifestyle and work demands of a military officer compared to a civilian employee are different. As a result, the causal factors identified in previous retention studies may not generalize to military aviators.

Within the last couple of years, military aviation has experienced an increased number of pilots departing for the commercial airlines. In 1997 the Chief of Naval Operations, Air Warfare Division (N-88), commissioned an aviation retention working group which identified five major areas that affected Naval aviator retention: compensation, quality of life, work environment, economic trends and other indicators (D. McGinn, personal communication, January 1998). Service leaders recognize that retention of quality pilots and NFOs is a serious problem for military readiness.

The Navy currently forecasts aviator retention and attrition by extrapolating historical trends. This thesis recommends that the Navy replace the current method with two alternative statistical techniques: *logistic regression* and *classification trees*. They are recommended for two reasons. First, the proposed techniques make significantly more accurate forecasts of aviator retention than the current method. Second, the proposed techniques, unlike the current method, can identify the significant variables affecting aviator retention. Use of the proposed techniques can therefore lead to the formulation of better aviator retention policies by the Navy.

This thesis employed logistic regression techniques and classification tree methodology to identify *post hoc* factors that influenced attrition of mid-grade aviators serving in the U.S. Navy between 1990 and 1996. Data on 13,310 pilots and NFOs was resident in the Officer Master File (OMF) maintained by the Bureau of Personnel (BUPERS). Restrictions imposed were: Naval aviators (pilots and NFOs), serving in the Unrestricted Line (no Warrant Officers or Limited Duty Officers) paygrades O-3 to O-5, with fewer than 20 years service. The dataset was partitioned and attrition was modeled using a random sample of 50 percent of the data. The remainder of the dataset was used to test the accuracy of the models.

While no model can accurately predict the highly personal retention decision of a single aviator, these models highlight several areas which, when used examine the behavior of groups of aviators, may have significant impact on future policy decisions. Both logistic and classification tree models identified duty stations in the north central U.S. and OCONUS as increasing attrition. Planners need to evaluate the perceived

hardships associated with duty in these areas and either increase incentives or improve the quality of life of service members stationed there. The same is true for assignment to non-flying billets. Decreasing the overall number of non-flying billets, filling these billets with non-aviation designated officers, or shortening the length of non-flying tours are all actions that may improve retention. Both models also indicate that Lieutenants (grade O-3) are the group most likely to attrite. Planners should target incentives to this group in order to decrease attrition. Variables which correlated to increased retention were Regular commissions and initial accession through the Naval Reserve Officer Training Corps (NROTC) program.

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I. INTRODUCTION

A. BACKGROUND

Recent news reports have raised alarm at the number of pilots leaving the military for higher-paying jobs in the civilian sector. The Philadelphia Inquirer (Diamond, 1998) found that pilots' "frustration over repeated foreign assignments, missions that don't require pilots to exercise combat skills, and a difficult promotion track" as well as an expanding airline industry which offers "frustrated military pilots steadier hours, stability at home, and the prospect of substantially higher pay" were reasons for leaving the service. The article also quotes Mr. Francis Rush Jr., head of Force Management Policy at the Pentagon, as stating if "present trends continue, there will be a significant shortage of pilots in the Navy within two years."

The retention problem is not limited to Naval Aviators (pilots); the resignation rate for Naval Flight Officers (NFOs) is up over 30 percent from two years ago. The increase in resignation rates for both pilots and NFOs, decreasing numbers of pilots applying for Aviation Continuation Pay (ACP), and increasing numbers of officers declining to screen for selection to Department Head prompted the Department of the Navy's Air Warfare Branch (N-88) to identify aviator retention as the number one issue for Naval Aviation (D. McGinn, personal communication, January 1998). To learn more about Naval aviator (pilot and NFO) attrition, N-88 commissioned several studies to determine, among other issues, if there is a relationship between retention and geographic location, membership in communities hit hardest during the drawdown, membership in

those with low post-command selection, membership in those with significant weapon system upgrades, and prevalence of working spouses.

A variety of different policies decisions, relating to accessions and training rates, tour lengths, incentive pay and bonuses, promotion opportunities etc., are made with the intent to maximize retention of quality Naval aviators. The Navy invests a substantial amount of time and money training each pilot and NFO and it is essential that there be sufficient numbers of qualified aviators at all career points to meet the fleet requirements (Cymrot, 1988). It is critical that policy decisions be based on variables that significantly affect retention.

The Honorable Henry Sodano, Director for Construction, Office of the Under-Secretary for Defense (Comptroller) testified during appropriations hearings before the House of Representatives that the most common reasons for personnel (not necessarily aviators) leaving the Navy:

> In our Retention/Separation Questionnaire, completed voluntarily by Sailors who are separating, reenlisting or extending, we ask which of 45 identified factors is the most important reason for leaving (or thinking of leaving) the Navy. Although the exact rank order of responses varies somewhat from year to year, the significant reasons have stayed much the same since the current version of the questionnaire began in 1990. For Sailors who left voluntarily in Fiscal Year 1996 the top six reasons were: (1) family separation; (2) promotion and advancement opportunity; (3) basic pay; (4) quality of leadership/management; (5) quality of Navy life; and (6) job enjoyment. (Hearings before the Subcommittee on Military Construction, of the House Appropriations Committee, 1997)

The current situation is not yet a crisis; however senior leaders have not ignored anecdotal evidence of widespread dissatisfaction within the aviation community.

B. STATEMENT OF PROBLEM

This research employs logistic regression techniques and classification tree methodology as a means to explain aviator retention. While some previous studies have used logistic regression, classification trees are a relatively new approach to military retention modeling. The analysis will consider data resident in the Bureau of Naval Personnel (BUPERS) Officer Master File (OMF) and the St. Louis Federal Reserve Bank's "FRED" database[1]. The OMF is an historical database and includes detailed information on the service member's current assignment, aviation related information, dependency data, initial entry information, personal demographic information, promotion information, separation codes, service school information, and specialty skill codes. In order to capture variables which influence alternative employment opportunities for Naval aviators, this study also incorporated data from the St. Louis Federal Reserve Bank's "FRED" database. The FRED database provides historical U.S. economic and financial data, including daily U.S. interest rates, monetary and business indicators, exchange rates, balance of payments and regional economic data.

1. Research Questions

The following research questions are raised as a means to accomplish this goal:

a. To identify, *post hoc*, significant predictive factors for aviators leaving the Navy;

[1] It turned out however, that this data could not conveniently be used in the analysis. See Chapter III (Section B) for further details.

b. To compare and contrast the logit regression and the classification tree methodologies for this data set;

c. To address policy implications of the resulting predictive models.

2. Scope, Limitations and Assumptions

Data for this study was limited to pilots and NFOs serving in the U.S. Navy between 1990 and 1996. Only those officers who had completed their initial obligated service, but had not yet reached 20 years of service, were eligible for the study. Data sources were the OMF managed by the BUPERS and economic data compiled by the Federal Reserve Bank of St. Louis, MO.

C. RESEARCH OBJECTIVES

The purpose of this research is to analyze personnel data contained in the BUPERS OMF and economic data available from the Federal Reserve Bank to determine the characteristics that best describe mid-career aviators who leave the Navy. The second objective is to contrast these indicators with variables identified by the Department of the Navy, Chief of Naval Operations Air Warfare Division (N-88) as contributing to decreased aviator retention. Lastly, this research contrasts these indicators with the characteristics of those officers who stay in the Navy and develops a predictive model that can be used by decision makers to help form policy affecting Naval aviator retention.

II. LITERATURE REVIEW

A. OVERVIEW

Employee turnover is defined as the process by which employees voluntarily or involuntarily sever ties with an organization (Kerr, 1997). Turnover can have significant detrimental effects on the individual and the organization. From the individual's perspective, it can result in loss of seniority and benefits, disruption of family and social life, career regression, and transition-related stress (Porter & Steers, 1991). An organization with higher than normal turnover rates will experience increased costs associated with recruiting, training, and assimilating new workers (Ibid, 1991). The organization can also experience loss of productivity, disruption in work environment, and decreased satisfaction among those employees who stay (Ibid, 1991). Determining the causal factors of voluntary turnover is of most interest to leaders and managers because organizational policies can have significant impact in this area.

B. TURNOVER

Excessive voluntary turnover is detrimental to any organization because of the monetary and psychological costs incurred (Kerr, 1997). Over the past several years, there has been a tremendous amount of research invested in understanding employee turnover. If these causal factors could be identified, then an organization could reduce the amount of money needed to train new employees. Currently, these costs have a significant impact on the organization's operating budget.

Hulin (1968) tested the effects of policy decisions aimed at reducing employee turnover for a Canadian manufacturing company. The company revised its personnel policies based on the results of a survey administered to measure job satisfaction. After the policy revisions were implemented the surveys were re-administered both to employees who had remained with the company and to those who had voluntarily left during the study. Hulin concluded that there is a strong negative relationship between job satisfaction and turnover.

Porter and Steers (1973) found that the majority of studies reported that job satisfaction was negatively correlated to turnover. They classified the results of 15 earlier studies into one of these four categories: organization-wide factors, immediate work environment, job-related factors, and personal factors. They found that a significant number of those employees who stay with an organization are more likely to experience the feeling of "met expectations." Based on a theory that each individual brings his or her own set of unique expectations to the employment situation, Porter and Steers created a decision model of employee turnover. They defined met expectations as the difference between initial expectations and what was actually encountered on the job. They hypothesized that the higher the level of an employee's met expectations, the higher the retention. The authors concluded that the issue of met expectations might play a significant role in explaining the turnover decision of employees.

Mobley (1977) theorized that a number of intermediate links exist between job-satisfaction and turnover. His model postulates that experience of job dissatisfaction leads to thoughts of quitting, which lead to an evaluation of the expected utility of a job

search and of the cost of quitting. He further states that if the expected utility of job search is acceptable, the next step is intent to search for alternate employment. In the next link of the model, intent to search leads to actual search, which is followed by an evaluation of the alternatives. Next, if the evaluation favors alternate employment it will stimulate intent to quit. The final step in the process is actual quitting.

In order to conduct empirical testing, Mobley, Horner, and Hollingsworth (1978) revised Mobley's original model. The revised model suggests that job satisfaction influences turnover through thinking of quitting, search and evaluation of alternate employment, and intention to quit. The authors found negative correlation between tenure and turnover, negative correlation between job satisfaction and turnover, and positive correlation between intention to quit and turnover. They concluded that job dissatisfaction affects thinking of quitting and intentions rather than turnover itself. Mobley et al. (1978) recommended that further study in organizational turnover consider behavioral and cognitive variables in addition to the emotional experience of job satisfaction. Similarly, Ilgen and Klein (1988) reviewed turnover research and found support for "expectancy × value" theories where turnover is related to job satisfaction and "ease and desirability of movement."

In an extensive review of the literature on employee turnover, Mobley, Griffeth, Hand, and Meglino (1979) updated earlier reviews. The authors divided their research summary into seven sections: individual demographic and personal variables, overall satisfaction, organizational and work environment factors, job content factors, external environment factors, and occupational groupings. They found age, tenure, overall job

satisfaction, and reaction to job content to be consistently and negatively associated with turnover. Other variables found to consistently relate to turnover included intentions to quit and job commitment.

In contrast to Porter and Steers' earlier review, Mobley, et al. (1979) reported inconclusive results with regard to pay, promotion, and peer group relations. They reported that, although the number of studies involving alternative employment was small, that variable had strong support in aggregate-level studies. Mobley, et al. (1979) found weak support for the met expectations hypothesis, reporting that "although realistic job previews have been shown to be a possible aid in reducing turnover, the psychology of this effect is not well understood." Lastly, they recommend multivariate studies as the best vehicle to explain the greatest variance in turnover and state that satisfaction "is an inadequate summary variable for capturing the effects of other demographic, organizational, occupational, or external variables (Mobley, et al., 1979)."

Steers and Mowday (1981) modeled turnover as a function of job satisfaction, job involvement, and organizational commitment. Their results showed that job expectations and attitudes, organizational characteristics and experiences, and job performance have a direct impact on the emotional responses of job satisfaction, job involvement and organizational commitment. In turn, economic and labor market conditions influence alternative job opportunities. Alternative job opportunities and individual characteristics influence expectations and attitudes. The authors state that job satisfaction, organizational commitment and non-work related influences (including spousal concerns,

family influences, and life outside the work environment) influence retention. (Steers & Mowday, 1981)

In a meta-analysis of 120 published studies in organizational behavior from 1979 to 1984 Cotton and Tuttle (1986) found pay, overall job satisfaction, age, tenure, gender, education, number of dependents, biographical information, and met expectations to be strong correlates of turnover. The authors also found unemployment rate, job performance, satisfaction with co-workers and promotion opportunities, and role clarity to be moderate correlates. Finally, O'Reilly (1991) conducted a review of studies of absenteeism and turnover and suggested that "people are less likely to leave their jobs when the external labor market makes leaving one's job costly or when alternative employment opportunities are fewer."

C. MILITARY TURNOVER

Studies of turnover have often separated civilian and military subjects because of a number of specific characteristics that are unique to the military. In the case of many military members with specialized training, the minimum service obligation can be more than eight years. If the service member decides to remain on active duty beyond his or her minimum service, he or she may incur additional obligations. These debts of service may result from accepting retention bonuses, accepting promotions, or executing permanent change of station orders. In the civilian sector employees are not normally required to make such specific decisions during their tenure. The civilian employee's decision to quit can be a more immediate response to internal or external stimulus. The

decision to remain in the military service carries with it a great deal more commitment than the decision to remain at a job in the civilian sector (Kerr, 1997).

Boesel and Johnson (1984) reviewed literature on military retention and reported on the effects of marital status and family size on retention. They found that married service members are more likely to attrite than single service members. Further, those married with children seem more likely to attrite than those married with no children.

In a RAND study of active duty retention, Doering and Grissmer (1985) echoed previous studies linking pay and tenure to retention. They found pay (paygrade) to be a strong negative correlate of attrition. Singley (1986) surveyed 302 West Coast Naval Tactical pilots and found that taste for military service, pay, job security, commissioning source, and spousal employment had significant effects on retention.

Marsh (1989) used the 1985 *Department of Defense Survey of Navy Officers and Enlisted Personnel* to develop a model of retention based on satisfaction with the military as a way of life, duty history, expectations and family status. Using multiple regression analysis, he proposed that the most important causes of retention intentions are months of active duty, the highest paygrade one expects to reach before leaving the Navy, and satisfaction with the military as a way of life. He also noted that, among Navy officers, the higher their present paygrade, the lower their satisfaction with the military life and the shorter their expected future years of service.

Perceived chances for promotion was also a significant predictor of retention in a study by Lakhani (1991). He combined the two disciplines of economics and psychology into a single theory of maximization of utility derived by an individual decision-maker.

In his study he hypothesized that the utility derived by a junior officer from staying or separating from the Army consists of three parts: pecuniary attributes such as pay and benefits; non-pecuniary benefits such as career commitment and career satisfaction; and personal attributes such as taste for Army life. Using data on 1,452 junior U.S. Army Officers from a 1986 *Department of Defense Survey of Officers*, his regression results suggested that retention could be improved by increasing satisfaction with military life, pay, and perceived chances of promotion.

Kocher and Thomas (1994) used logistic regression to analyze retention behavior of active duty Army nurses. Their model included external market factors, personal factors and work-related factors. Working with a longitudinal sample of active duty Army nurses (all of whom were officers) and the 1985 *Department of Defense Survey of Officers and Enlisted Personnel,* they found that satisfaction with work, military life, and location/assignment, as well as race and family status had significant effects on retention.

In a study focusing on the effects of downsizing, Evans (1995) attempted to identify common concerns of soldiers in the U.S. Army. She conducted interviews in 1992 with 179 active duty soldiers at a number of Army installations throughout the country. Although the sample was a cross-section of different ranks and occupational specialties, Evans found that several topics were consistent areas of concern for all participants. She concluded that satisfaction, commitment, stress and perceived quality of leaders are all significantly correlated to turnover intentions.

Using an Annualized Cost of Leaving (ACOL) model for Navy aviators, Riebel (1996) examined the effects of aviation bonus pays on aviator retention. He employed

logistic regression to predict the retention decision of Naval aviators based on expected future earnings and taste for military service. He found that financial incentives have a significant impact on retention.

Zinner (1997) used a multivariate logistic regression model to determine the relative importance of factors in explaining actual quit behavior of junior Marine Corps officers. He used a sample of 692 officers from the 1992 *Department of Defense Survey of Officers and Enlisted Personnel and Their Spouses* with 1996 follow-up retention information from the Defense Manpower Data Center's Master Loss File. Zinner (1997) concluded that commissioning source, occupational specialty, deployment to Southwest Asia, satisfaction with life in the Marine Corps, concerns over the drawdown, job search within the last twelve months, and belief that job skills would transfer to the civilian market all significantly influenced retention.

D. CURRENT RETENTION MODEL

Cumulative Continuation Rate (CCR) methodology was devised by the U.S. Air Force to measure the continuation of its pilots (Cymrot, 1988). In response to a request from Congress to provide consistent data across the services, the U.S. Navy has adopted this methodology to report its pilot continuation (Cymrot, 1988). The CCR is generally defined as the:

> ...probability that a pilot at one year of service (YOS) will continue in the Navy until some other year of service. CCRs are most commonly calculated for the periods from YOS 6 to YOS 11 (CCR_{6-11}) and for YOS 3 to YOS 12 (CCR_{3-12}). In measuring CCRs, year groups are used as proxies for years of service. (Cymrot, 1988)

This study will look at the CCR_{6-11} since that is the measurement that most closely describes mid-grade careers.

Annual continuation rates are simply the ratio of the inventory of pilots at the beginning of a year to the inventory at the end of the year for a particular year group. A CCR is calculated by multiplying together the annual continuation rates for the desired range of years of service (YOS). Table 1 illustrates the calculation of the CCR for YOS six through eleven (CCR_{6-11}) for 1987. Using this methodology, the 1987 CCR_{6-11} was 34.9 percent. "According to the proponents of this methodology, this percentage represents the probability that a pilot with 6 years of service will still be in the Navy at 11 years of service." (Cymrot, 1988)

Table 1: Calculation of the CCR_{6-11} for 1987

Years of Service	Year Group	Beginning Inventory	Ending Inventory	Continuation Rate
6	81	973	797	81.9
7	80	489	359	73.4
8	79	439	345	78.6
9	78	374	338	90.4
10	77	419	381	90.9
11	76	343	308	89.8
CCR_{6-11}				34.9

Source: Cymrot, 1988

There are many problems associated with the CCR. Cymrot (1988) states that it is unclear if the CCR applies to a single year group or all year groups and also whether it applies to the entire period or just a single year.

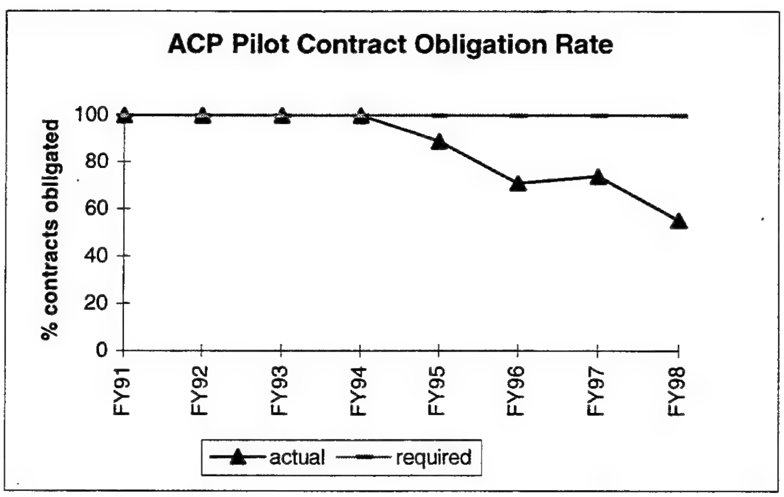
> In some cases, relatively low CCR_{6-11}s are associated with relatively high losses in a year. However the correlation coefficient is not consistently significant across all communities, making the CCR_{6-11} an unreliable indicator of losses. Not only is the CCR_{6-11} sensitive to relatively small changes in the inventory, but changes resulting from redistributions do not necessarily track with retention requirements. (Cymrot, 1988)

As a forecasting tool, the CCR is not flexible enough to incorporate additional information, or to be used for sensitivity analysis. Another, more flexible forecasting tool is needed.

E. NAVAL AVIATOR RETENTION

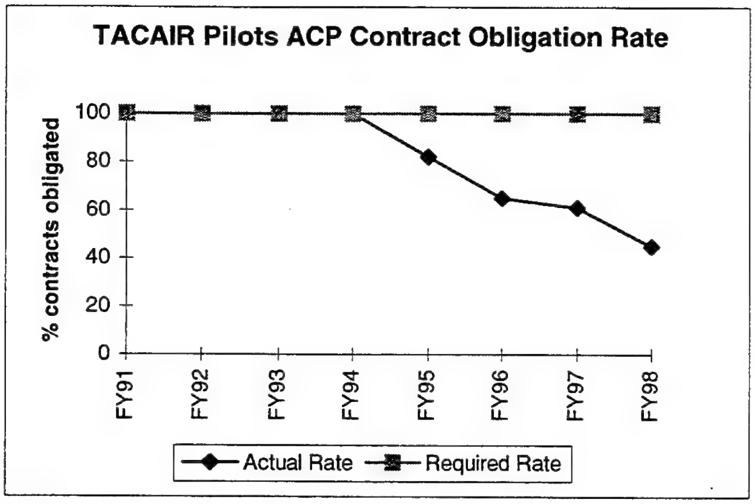
Accurate estimates of future retention rates are critical in order to minimize expenditures for accessions and training. A model of future retention would allow planners to anticipate shortfalls at different career points and take corrective action through the various policy measures at their control (Cymrot, 1988). In response to growing concerns over Naval aviator attrition the Chief of Naval Operations, Air Warfare Division established an aviation retention team in 1997 to assess fleet concerns, brief squadrons on initiatives impacting aviation retention and ensure open communications between N-88 and the fleet. Representatives from BUPERS, N-88 and Type Command (TYCOM) visited all East and West Coast Fleet Replacement Squadron (FRS) locations, and all Training Command (TRACOM) bases. The investigative team characterized the current retention situation as within manageable levels, but added, "We are experiencing the leading indicators of a retention challenge (D. McGinn, personal communication, January 1998)." They cited low levels of ACP Pilot Contract Obligation rates, increasing resignation rates, increasing numbers of O-4's declining Department Head screen and

decreasing CCRs in some communities were indications of a serious problem arising. Naval aviators who sign an ACP contract are obligated to serve through their 14th year in the Navy, ensuring that there will be enough mid-grade (lieutenant commander and commander) pilots and NFOs to fill required billets. An obligation rate less than the required amount implies that there will be a shortage of qualified pilots. Figures 1 and 2 illustrate the decline in Pilot Contract Obligation rates over an eight-year period starting in fiscal year 1991. Figure 1 shows a marked decline in contract obligation rates for all Navy pilots since fiscal year 1994. Starting in fiscal year 1995, the Navy has fallen short of the required number of pilots accepting ACP contracts. This graph includes pilots from all communities. Looking just at the obligation rates from TACAIR pilots in Figure 2, it is evident that dramatic drop in TACAIR obligations is a driving force behind the phenomenon.



Source: N-88, 1997

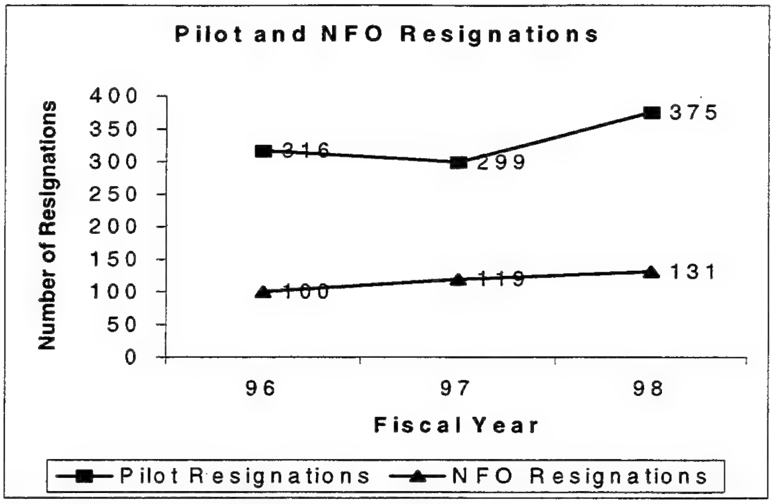
Figure 1: Pilot ACP Contract Obligation Rate FY91–FY96



Source: N-88, 1997

Figure 2: TACAIR Pilot ACP Contracts Obligation Rate FY91-FY96

The increasing number of pilot and NFO resignations mirrors the rise in the number of pilots declining to accept ACP contracts. Figure 3 illustrates the increasing trend in pilot and NFO resignations between fiscal years 1996 and 1998. The required number of pilots and NFOs has been roughly consistent for the years 1996 through 1998 so a sustained trend of increased resignations will have an adverse impact on the Navy's ability to maintain sufficient aviators.



Source: N-88, 1997

Figure 3: Pilot and NFO Resignations FY96-FY98

1. Aviation Career Incentive Pay

One of the most familiar programs to boost aviator retention is Aviation Career Incentive Pay (ACIP). ACIP falls under section 301a of title 37, United States Code and was recently amended in the fiscal year 1998 Defense Authorization Bill. The previous and amended ACIP scales are detailed in Tables 2 and 3. By examining the points at which the ACIP amount rises and falls, one can track the points in an aviator's career when he or she is most valuable to the Navy. Until the officer reaches six years of service, ACIP is little inducement for retention. Most aviators are still serving off their initial obligation for flight school and are unable to resign until approximately their eighth year.

At the six year point ACIP takes a huge jump and under the amended rates it increases once more at year 14. This coincides directly with the end of obligated service

for those officers who accept a bonus contract under the Aviation Continuation Pay (ACP) program (see below). Under the pre-1998 ACIP scales the monthly rate dropped dramatically as the aviator reached retirement. The new rates continue the $840 payment past the 20-year mark before tapering off. This may satisfy those aviators who had complained about an "inverted pay scale" in which junior officers often made more money than their Commanding Officers. The limitation of ACIP is that it is paid to all aviators regardless of sub-community and therefore cannot be targeted to a specific shortage to improve retention.

Table 2: Phase I Changes to Aviation Career Incentive Pay

Years of aviation service (including flight training) as an officer:	Previous monthly rate:	Amended monthly rate:
2 or fewer	$125	$125
Over 2	156	156
Over 3	188	188
Over 4	206	206
Over 6	650	650
Over 14 *	650	840
Phase II		
* Category deleted as a result of 1998 Defense Authorization Bill		

Source: Title 37, USC

Table 3: Phase II Changes to Aviation Career Incentive Pay

Years of service as an officer:	Previous monthly rate:	Amended monthly rate:
Over 18 *	$585	$840
Over 20	495	840
Over 22	385	585
Over 23 **	385	495
Over 24 **	385	385
Over 25	250	250
* Category deleted as a result of 1998 Defense Authorization Bill		
** Categories added as a result of 1998 Defense Authorization Bill		

Source: Title 37, USC

2. Aviation Continuation Pay

Another familiar compensation program is Aviation Continuation Pay (ACP), more commonly referred to as the aviation bonus. ACP replaced the Aviation Officer Continuation Program (AOCP) in 1989. To be eligible, an officer must meet all the requirements to receive ACIP; be in a "critical aviation specialty" as designated by the Secretary of the Navy; be in a pay grade below O-6; be qualified to perform operational flying duty; have completed at least six but fewer than 13 years of active duty; and have completed any active duty service commitment incurred for undergraduate aviator training (Title 37, section 301b, U.S. Code).

Officers are eligible to leave the Navy at the conclusion of their initial minimum service requirement (MSR), generally between the sixth and eighth year of service. ACP is offered to communities with projected shortages of mid-grade Lieutenant Commanders to serve as aviation squadron department heads or officers in charge. The size of the

bonus depends on the projected shortage in the sub-community in question. The maximum annual bonus allowed by law is $25,000 (recently increased from $12,000). (Title 37, section 301b, U.S. Code)

F. CURRENT RETENTION DILEMMA

Results of the N-88 (D. McGinn, personal communication, January 1998) retention team's study on aviation retention can be broken down into five broad categories: compensation, quality of life, work environment, economic trends and other indicators. Pay or other compensations (i.e., ACP, retirement, and special pay and allowances) were a recurring source of disappointment among aviators. The retention team also stressed the need for the Navy to continue to press for legislative initiatives to increase aviation officer compensation. Responses from the fleet to N-88's queries reflected concerns over pay raises that fail to keep pace with inflation, the 1986 reduction in retirement benefits, and the inverted pay scale of the aviation community. A common theme from all the units visited by the retention team was that aviators want the Navy to emphasize taking care of families. (D. McGinn, personal communication, January 1998)

High personnel deployment tempo and a general perception that benefits such as medical treatment, schools and housing are eroding were listed as contributing to the increase in attrition. Common career complaints focus on high unit operational tempo, the high level of additional duties and the requirement for aviators to serve in non-flying billets or disassociated tours. The growing economy and the expanding airline industry are also cited as reasons for increased resignations among aviators. Recent base closures have affected the locations available for all military members to be stationed. The

working group stated that among other factors, low ACP "take rates" and increasing numbers of O-4's declining Department Head screening were leading indicators of a retention problem (D. McGinn, personal communication, January 1998).

Efforts to affect turnover among Naval aviators consist mainly of ACP and ACIP. Both programs reward longevity, although ACIP is offered to all aviators, both pilot and NFO, regardless of sub-community. Planners are able to use ACP to target specific sub-communities and qualifications (pilot and/or NFO) to attempt to alleviate specific retention problems.

G. SUMMARY

Previous studies in civilian retention behavior have overwhelmingly shown that job satisfaction is positively related to retention (Hulin, 1968; Porter & Steers, 1973; Mobley, 1977; Mobley et al., 1978; Mobley et al., 1979; Ilgen & Klein, 1988; Steers & Mowday, 1981; Cotton & Tuttle, 1986). The availability of alternative employment or the belief that one's job skills would transfer to another job was negatively related to retention (Mobley, 1977; O'Reilly, 1991). Age and tenure were negatively related to retention (Mobley et al., 1978; Cotton & Tuttle, 1986). Satisfaction with one's work environment, and job content were found to be positively related to retention (Mobley et al., 1979; Steers & Mowday, 1981; Cotton & Tuttle, 1986). Higher pay was found to increase retention (Cotton & Tuttle, 1986). Retention generally increased with an increase in the number of dependents (Cotton & Tuttle, 1986). Cotton and Tuttle also found correlation between retention and demographic variables such as gender, race, education and biographical information.

Military studies in retention echoed civilian research by showing that job satisfaction is positively related to retention (Singley, 1986; Kocher & Thomas, 1994; Evans, 1995). The availability of alternative employment or the belief that one's job skills would transfer to another job was negatively related to retention (Zinner, 1997). Age and tenure were negatively related to retention (Doering & Grissmer, 1985; Marsh, 1989). Satisfaction with one's work environment, job content, and the military way of life was found to be positively related to retention (Singley, 1986; Marsh, 1989; Lakhani, 1991; Kocher & Thomas, 1994; Evans, 1995; Zinner, 1997). Higher pay was found to increase retention (Doering & Grissmer, 1985; Singley, 1986; Lakhani, 1991; Riebel, 1996). Retention generally increased with an increase in the number of dependents (Boesel & Johnson, 1984; Kocher & Thomas, 1994). Several studies found correlation between retention and such demographic variables as commissioning source, location of military assignment, gender and race (Singley, 1986; Kocher & Thomas, 1994; Zinner, 1997).

The N-88 working group identified five major areas that affected aviator retention. Compensation, quality of life, work environment, economic trends and other indicators were cited as reasons for the current retention trends (D. McGinn, personal communication, January 1998). A list of independent variables (see Appendices A and B) was developed based on previous research and the findings of the N-88 working group. Using the Bureau of Personnel Officer Master File and economic data from the Federal Reserve Bank, this research evaluates *post hoc* variables which significantly influence the retention decision of Naval aviators, the dependent variable.

III. METHODS

A. BUPERS OMF

1. Description of OMF Database

This database, maintained by BUPERS, contains 311 fields of information on every officer in the Navy and Naval Reserve. Records are indexed by social security number and individual fields are organized into broad categories (BUPERS, 1994). The OMF includes detailed information on the service member's current assignment, aviation related information, dependency data, initial entry information, personal demographic information, promotion information, separation codes, service school information, and specialty skill codes.

2. Data Extraction

The office of BUPERS (code PERS-1023) provided data for the analysis. The data consisted of all aviators serving between 1990 and 1997 in the active duty U.S. Navy, active duty U.S. Naval Reserve, and U.S. Naval Reserve Training and Administration of Reserve (TAR) program. Separate years were compared to determine the first time that an individual record "dropped out" of the database. For example, if a record appeared in previous years but failed to appear in 1995 that individual was classified as leaving in 1994. All records were classified as either "leavers" or "stayers" and, if applicable, tagged with the year they left the service. This procedure resulted in 29,490 records indexed by social security number. A subset of this data was extracted in order to examine the characteristics only of officers who had fulfilled their initial

obligated service and had not yet reached retirement age. Records of officers who failed to select for promotion were dropped to avoid the inclusion of officers who may have been involuntarily separated. Records with more than one null field were also eliminated. The resulting data set consisted of 13,310 Naval aviators in the grades of O-3, O-4, and O-5, who served between 1990 and 1996.

B. ECONOMIC INDICATORS

Economic data was obtained from the Federal Reserve Bank of St. Louis' "FRED" database. FRED provides historical U.S. economic and financial data, including U.S. interest rates, monetary and business indicators, and exchange rates. Monthly data was extracted for the period covered by the OMF data (1990 to 1997) for prime interest rates, housing starts, S&P 500 total return, personal income in current dollars, consumer price index, seasonally adjusted consumer price index, unemployment and employment in the transportation industry. This data was converted from monthly to yearly averages and was appended to the OMF file.

Although economic growth and job opportunities have been used as indicators of the ease or desirability of leaving one's company or the military, this study encountered problems which precluded the use of economic data in either model (Ilgen & Klein, 1988; Steers & Mowday, 1981; Cotton & Tuttle, 1986; O'Reilly, 1991; Zinner, 1997). The economic statistics supplied by the Federal Reserve Bank were compiled on a monthly basis whereas the attrition data for Naval aviators only reflected the year in which the individual left the service. Officers who separated in January might have been influenced by quite different economic and job market factors than those who separated in December

of the same year. Another confound was trying to determine how many months, or years, of historical data to include when considering the influence of economic factors on an individual's decision to leave the Navy. A strong upward shift in the job market might have the same effect on the retention decision as a long period of steady, but slower, growth. Based on these arguments, this study did not include the economic database in the models.

C. ANALYSIS

The OMF data set was randomly divided into two equal-sized parts. The first half was used for exploratory analysis and the second half was reserved to test the final logistic regression and classification tree models. Numerical summaries provided a statistical synopsis of the data in a tabular format.

1. Logistic (Logit) Regression

In previous research, logistic, or logit, regression has been a widely used technique for attrition analysis (Marsh, 1989; Lakhani, 1991; Kocher & Thomas, 1994; Riebel, 1996; Zinner, 1997). Logit regression explains a dependent variable by a linear combination of independent variables. In this analysis, the dependent variable is categorical (i.e. whether or not an aviator attrites) and the goal of the analysis is to determine the probability an officer with a given set of characteristics will attrite. Logit regression results in "predictive values which correspond to the probability of a positive (attrition) outcome" (Martin, 1995). The logistic model is defined by

$$\Pr[Y_i = 1 \mid X_i] = 1/[1+\exp(-X_i\beta)]$$

where Y_i is the dependent variable, attrition, for member "i" and X_i represents the vector of independent variables for member "i." The vector of regression coefficients for the model is represented by β.

Using S-Plus (Mathsoft Inc., 1995) the OMF data were modeled using logit regression. A random sample of data (50 percent) was selected to build the models and the remainder was saved to test their predictive power. Appendix C, Table 1 shows a summary of the counts from the 6655-member data set broken down by factor response. The first step was to build a model that included all potential predictors. The magnitude of the t-values were computed and the variable corresponding to the smallest of these was deleted if its t-value was insignificant at $\alpha = 0.05$. This process was repeated until all remaining t-values were significant.

2. Classification Tree

Tree based models are an exploratory technique to uncover structure in data and are an alternative to logistic models for classification or regression problems. Classification trees are similar to regression in that they model a categorical dependent variable, Y_i, by a vector of independent variables, X_i for member "i." The independent variables can be either numeric or categorical. The result of a classification tree is a determination of a most probable level of the dependent variable. The resulting tree's terminal nodes or "leaves" contain groups of cases with similar values of their independent variables and, it is expected, similar values for the dependent variable.

Beginning with the parent node, which contains all the records in the dataset, S-Plus calculates the deviance of that node to determine which partition of a node is "most likely" given the data. The deviance formula follows:

$$\text{Deviance}_i = -2 * \sum_k (n_{ik} * \log(p_{ik}))$$

where "i" labels the node, "k" labels the classes in the node (here these are "attrite" or "no attrite"), n_{ik} represents the number of cases with class "k" in node "i" and p_{ik} is the multinomial probability associated with node "i" and class "k." For each node, S-Plus looks at every variable and every possible binary split within that variable and chooses the variable and split that brings about the maximum reduction in deviance, and splits the node into two child nodes. Each pair of child nodes has a combined deviance that is no larger than that of their parent. (Venables & Ripley, 1994) The procedure is repeated for each child node and the dataset is successively split into increasingly homogeneous subsets until it is infeasible to continue. By default, S-Plus grows an overly large tree and the analyst must reduce the tree to an optimal predictive size. Cross-validation is a method to identify the optimal tree size and pruning enables the analyst to reduce the over-fitted model to the optimal number of terminal nodes.

IV. RESULTS

A. DESCRIPTIVE STATISTICS

Of the 6,655 aviators sampled, 79 percent were in flying billets as determined by the aviation billet indicator (ABI). The largest percentage of the population (25 percent) had a source code, which gives the program under which the officer qualified for original appointment, indicating Augment Reserve (AR) or Temporary Officer to Regular appointment. Twenty percent entered the Navy through the Naval Reserve Officer Training Corps (NROTC) program, 19 percent were Naval Academy graduates (USNA), 13 percent had a source code of Reserve, ten percent were Aviation Officer Candidate School (AOCS) graduates, and the remainder were Naval Aviation Cadets (NAVCAD), graduates of Systems Engineering Course (NESEP) after commissioning from the officer candidate program, Naval Flight Officer Candidates (NFOC), or others.

Forty-three percent of aviators were designated Regular Navy Unrestricted Line Officer Pilots (1310), 22 percent were Naval Reserve Unrestricted Line Officer Pilots (1315), 24 percent were Regular Navy Unrestricted Line Officer Naval Flight Officers (1320), and the remaining 11 percent were Naval Reserve Unrestricted Line Officer Naval Flight Officers (1325). Lieutenants (O-3) made up 75 percent of the sample, 18 percent were Lieutenant Commanders (O-4), and seven percent were Commanders (O-5).

Nearly all, 97 percent, of the aviators sampled were male. The vast majority, 95 percent, were Caucasian, two percent were Black and three percent were other. Married officers made up 75 percent of the sample (three percent had military spouses) and the

majority (61 percent of married aviators) had one or more children. The locations of their current duty stations were primarily in the southern U.S. (47 percent), followed by the west (31 percent) and out of the continental U.S. (15 percent). Five percent of aviators were stationed in the northeast, and the remaining two percent in the north central U.S.

Year groups (generally the year in which an officer is commissioned) between 1979 and 1993 were fairly evenly represented with greater than three percent of the population in each year group, and a peak of ten percent for year group 1986. Year groups from 1973 to 1978 had small percentages (less than percent) for each year and were grouped into a category called "73 to 79."

B. ANALYSIS OF THE RETENTION DECISION

The decision to leave the Navy was analyzed by ABI, source code, dependent status, designation, grade, and region. Retention by ABI reveals that aviators in flying billets are very nearly as likely to leave the service as those in non-flying billets. Flying billets made up 79 percent of the population and accounted for 77 percent of those leaving. Table 4 displays a cross-tabulation of ABI and retention. The rows of the table reflect non-flying and flying billets, whereas the columns contain the two responses to the variable "leave." The "STAY" column is all aviators in who remain in the Navy; the "LEAVE" column contains all attrites. In each block of the table the four numbers represent: total number of aviators in that block, percent of tow total, percent of column total, and percent of total. S-Plus uses Pearson's χ^2 statistic to test for independence of the rows and columns of the table. A significant p-value ($p < 0.01$) allows one to reject

the null hypothesis that the rows and columns are statistically independent. This table shows a χ^2 test with a "significant" p-value.

Table 4: Retention by Aviation Billet Indicator (ABI)

```
+----------+
|N         |
|N/RowTotal|
|N/ColTotal|
|N/Total   |
+----------+
ABI     |STAY    |LEAVE   |RowTotl|
-------+-------+-------+-------+
NO FLY | 847    | 532    |1379   |
       |0.61    |0.39    |0.21   |
       |0.20    |0.23    |       |
       |0.13    |0.08    |       |
-------+-------+-------+-------+
FLY    |3453    |1823    |5276   |
       |0.65    |0.35    |0.79   |
       |0.80    |0.77    |       |
       |0.52    |0.27    |       |
-------+-------+-------+-------+
ColTotl|4300    |2355    |6655   |
       |0.65    |0.35    |       |
-------+-------+-------+-------+
Test for independence of all factors
Chi^2 = 7.750 d.f.= 1 (p=0.005)
```

Aviators whose source code was Reserve made up only 13 percent of the population but accounted for 34 percent of those leaving. The next most significant source was AOCS whose graduates accounted for 11 percent of the total population and 24 percent of those leaving. Table 5 displays a cross-tabulation of current source code and retention. The rows of the table reflect source codes, whereas the columns contain the two responses to the variable "leave." The "STAY" column is all aviators in who remain in the Navy; the "LEAVE" column contains all attrites. In each block of the table the four numbers represent: total number of aviators in that block, percent of tow total, percent of column total, and percent of total. This table also shows a χ^2 test with a "significant" p-value.

Table 5: Retention by Current Source Code

N N/RowTotal N/ColTotal N/Total			
SOURCE	STAY	LEAVE	RowTotl
acad	1103 0.871 0.257 0.166	164 0.129 0.070 0.025	1267 0.190
aocs	161 0.220 0.037 0.024	570 0.780 0.242 0.086	731 0.110
ar	1497 0.891 0.348 0.225	183 0.109 0.078 0.027	1680 0.252
nfoc	81 0.210 0.019 0.012	304 0.790 0.129 0.046	385 0.058
nrotc	1187 0.861 0.276 0.178	192 0.139 0.082 0.029	1379 0.207
other	181 0.567 0.042 0.027	138 0.433 0.059 0.021	319 0.048
res	90 0.101 0.021 0.014	804 0.899 0.341 0.121	894 0.134
ColTotl	4300 0.65	2355 0.35	6655

Test for independence of all factors
Chi^2 = 3069.345 d.f.= 6 (p=0)

Unmarried aviators with no dependents were the most likely to leave the service, accounting for 23 percent of the sample population and 27 percent of the group leaving. Married aviators who only had one child and whose spouse was civilian were the next

most likely to leave. They made up 18 percent of the sample and 19 percent of the leavers. The rest of the classifications were more likely to remain in the service. Table 6 displays a cross-tabulation of dependent code and retention. The rows of the table reflect dependent codes, whereas the columns contain the two responses to the variable "leave." The "STAY" column is all aviators in who remain in the Navy; the "LEAVE" column contains all attrites. In each block of the table the four numbers represent: total number of aviators in that block, percent of tow total, percent of column total, and percent of total. This table also shows a χ^2 test with a "significant" p-value.

Table 6: Retention by Dependent Code

```
+----------+
|N         |
|N/RowTotal|
|N/ColTotal|
|N/Total   |
+----------+
```

DEPS	STAY	LEAVE	RowTotl
no sp >1 ch	45 0.6429 0.0105 0.0068	25 0.3571 0.0106 0.0038	70 0.0105
mil sp	95 0.6835 0.0221 0.0143	44 0.3165 0.0187 0.0066	139 0.0209
mil sp >1 ch	38 0.7755 0.0088 0.0057	11 0.2245 0.0047 0.0017	49 0.0074
no dep	935 0.5959 0.2174 0.1405	634 0.4041 0.2692 0.0953	1569 0.2358
spouse no ch	1169 0.6466 0.2719 0.1757	639 0.3534 0.2713 0.0960	1808 0.2717
spouse 1 ch	737 0.6178 0.1714 0.1107	456 0.3822 0.1936 0.0685	1193 0.1793
spouse 3 ch	305 0.7367 0.0709 0.0458	109 0.2633 0.0463 0.0164	414 0.0622
spouse >3 ch	82 0.7009 0.0191 0.0123	35 0.2991 0.0149 0.0053	117 0.0176
spouse 2 ch	894 0.6898 0.2079 0.1343	402 0.3102 0.1707 0.0604	1296 0.1947
ColTotl	4300 0.65	2355 0.35	6655

Test for independence of all factors
Chi^2 = 53.141 d.f.= 8 (p=0)

Aviators with designator 1315 were the most likely to separate. 1315's made up 22 percent of all mid-career aviators in the sample, but accounted for 51 percent of those who left the Navy. 1325's were 11 percent of the total with 26 percent of the leavers. Table 7 displays a cross-tabulation of designation and retention. The rows of the table reflect designations, whereas the columns contain the two responses to the variable "leave." The "STAY" column is all aviators in who remain in the Navy; the "LEAVE" column contains all attrites. In each block of the table the four numbers represent: total number of aviators in that block, percent of tow total, percent of column total, and percent of total. This table also shows a χ^2 test with a "significant" p-value.

Table 7: Retention by Primary Designation

Cell contents: N / N/RowTotal / N/ColTotal / N/Total

DESIG	STAY	LEAVE	RowTotl
1310	2519 0.880 0.586 0.379	342 0.120 0.145 0.051	2861 0.43
1315	286 0.191 0.067 0.043	1208 0.809 0.513 0.182	1494 0.22
1320	1389 0.882 0.323 0.209	186 0.118 0.079 0.028	1575 0.24
1325	106 0.146 0.025 0.016	619 0.854 0.263 0.093	725 0.11
ColTotl	4300 0.65	2355 0.35	6655

Test for independence of all factors
Chi^2 = 3213.413 d.f.= 3 (p=0)

Lieutenants were by far the most likely grade to leave, making up 75 percent of the population and over 91 percent of those who separated. The other grades were more likely to stay in the Navy. Table 8 displays a cross-tabulation of grade and retention. The rows of the table reflect grades O-3 through O-5, whereas the columns contain the two responses to the variable "leave." The "STAY" column is all aviators in who remain in the Navy; the "LEAVE" column contains all attrites. In each block of the table the four numbers represent: total number of aviators in that block, percent of tow total, percent of

column total, and percent of total. This table also shows a χ^2 test with a "significant" p-value.

Table 8: Retention by Grade

```
+----------+
|N         |
|N/RowTotal|
|N/ColTotal|
|N/Total   |
+----------+
GRADE   |STAY   |LEAVE  |RowTotl|
--------+-------+-------+-------+
O-3     |2837   |2148   |4985   |
        |0.5691 |0.4309 |0.749  |
        |0.6598 |0.9121 |       |
        |0.4263 |0.3228 |       |
--------+-------+-------+-------+
O-4     |1003   | 164   |1167   |
        |0.8595 |0.1405 |0.175  |
        |0.2333 |0.0696 |       |
        |0.1507 |0.0246 |       |
--------+-------+-------+-------+
O-5     | 460   |  43   |503    |
        |0.9145 |0.0855 |0.076  |
        |0.1070 |0.0183 |       |
        |0.0691 |0.0065 |       |
--------+-------+-------+-------+
ColTotl |4300   |2355   |6655   |
        |0.65   |0.35   |       |
--------+-------+-------+-------+
Test for independence of all factors
Chi^2 = 520.099 d.f.= 2 (p=0)
```

Aviators stationed OCONUS made up only 15 percent of the total population but accounted for 27 percent of those who left the Navy. Table 9 displays a cross-tabulation of geographic region of last duty station and retention. The rows of the table reflect geographic regions in the U.S. and out of the continental U.S., whereas the columns contain the two responses to the variable "leave." The "STAY" column is all aviators in who remain in the Navy; the "LEAVE" column contains all attrites. In each block of the table the four numbers represent: total number of aviators in that block, percent of tow

total, percent of column total, and percent of total. This table also shows a χ^2 test with a "significant" p-value.

Table 9: Retention by Region

N
N/RowTotal
N/ColTotal
N/Total

REGION	STAY	LEAVE	RowTotl
NE	221	105	326
	0.6779	0.3221	0.049
	0.0514	0.0446	
	0.0332	0.0158	
S	2199	963	3162
	0.6954	0.3046	0.475
	0.5114	0.4089	
	0.3304	0.1447	
NC	49	56	105
	0.4667	0.5333	0.016
	0.0114	0.0238	
	0.0074	0.0084	
W	1467	598	2065
	0.7104	0.2896	0.310
	0.3412	0.2539	
	0.2204	0.0899	
OCONUS	364	633	997
	0.3651	0.6349	0.150
	0.0847	0.2688	
	0.0547	0.0951	
ColTotl	4300	2355	6655
	0.65	0.35	

Test for independence of all factors
Chi^2 = 431.574 d.f.= 4 (p=0)

C. LOGISTIC MODEL

The resulting logistic model is summarized in Table 10. To test the null hypothesis that all X variables' coefficients are zero, one can compare the difference between the null deviance and the residual deviance to a χ^2 distribution with 18 degrees

of freedom. A $\chi^2(18)$ has an expected value of 18 and a standard deviation of 4.243. This approximation shows that the model is significant at a very high confidence level (8648.958 – 4650.468 = 3398.490). The probability of a greater χ^2, with 18 degrees of freedom (the final model includes 18 more parameters than the intercept-only model), is $p < 0.01$. We reject the null hypothesis that coefficients on all 18 variables are zero. (Hamilton, 1992)

In summary, designators 1315 and 1325 significantly ($\alpha = .01$) increase the probability of attrition compared to designator 1310; regions three and five increase the probability of attrition as compared to region one; and source codes AOCS, NFOC, Reserve and other increase the probability of attrition as compared to source code USNA. In contrast, regions two and four decrease the probability of attrition as compared to region one; source codes AR and NROTC decrease the probability of attrition as compared to source code USNA; grades O-4 and O-5 decrease the probability of attrition as compared to grade O-3; an increase in ACP annual amount significantly decreases the probability of attrition; and an ABI which indicates a flying billet decreases the probability of attrition. Other variables were removed from the model for insignificance.

Table 10: Logistic Model Summary

Variable	Value	Std. Error	t-Value
(Intercept)	-2.257	0.233	-9.688
desig1315	1.962	0.148	13.232
desig1320	-0.077	0.105	-0.732
desig1325	2.451	0.190	12.894
acp.ann.amt	-0.008	0.002	-4.750
abi	-0.801	0.101	-7.893
grade4	-1.515	0.155	-9.755
grade5	-2.545	0.248	-10.257
region2	-0.382	0.183	-2.091
region3	0.775	0.326	2.373
region4	-0.237	0.187	-1.271
region5	1.272	0.195	6.523
aocs	1.390	0.178	7.832
ar	-0.094	0.122	-0.769
nfoc	0.988	0.221	4.466
nrotc	-0.239	0.124	-1.920
other	0.540	0.180	2.992
res	1.855	0.194	9.545
mos.oper.fly	0.017	0.002	9.898
Null Deviance: 8648.958 on 6654 degrees of freedom			
Residual Deviance: 4650.468 on 6636 degrees of freedom			

D. CLASSIFICATION TREE MODEL

Random 10-fold cross-validation identified an optimal tree size of 22 terminal nodes. Figure 4 shows the relationship between deviance and model size.

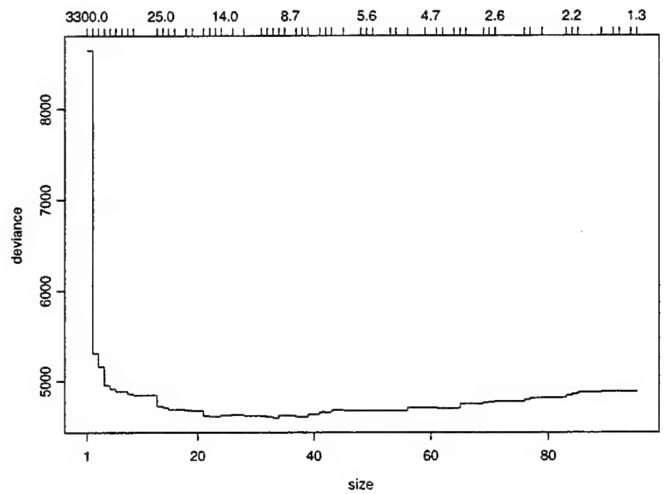


Figure 4: Tree Model Size vs Deviance

The tree model is depicted in Figure 5. The number inside each node is the probability of attrition, expressed as a percentage, and the number below the node is the number of observations in that node. The code for this tree can be found in Appendix D. The root shows an attrition probability of 0.352, which is the attrition rate of the whole data set. Rectangular terminal nodes are called leaves. The first split divides the root into two sets (aviators in designators 1310 or 1320 versus those with designator 1315 or 1325). As an example of how to use the tree model, the group of aviators with a 1310 or 1320 designator, whose last duty station was in regions 3 or 5, whose ACP term was less than 12 months and who had fewer than 130.5 months of operational flight time had a frequency of attrition of 0.397. This number becomes our estimate of probability of attrition for future aviators with these characteristics.

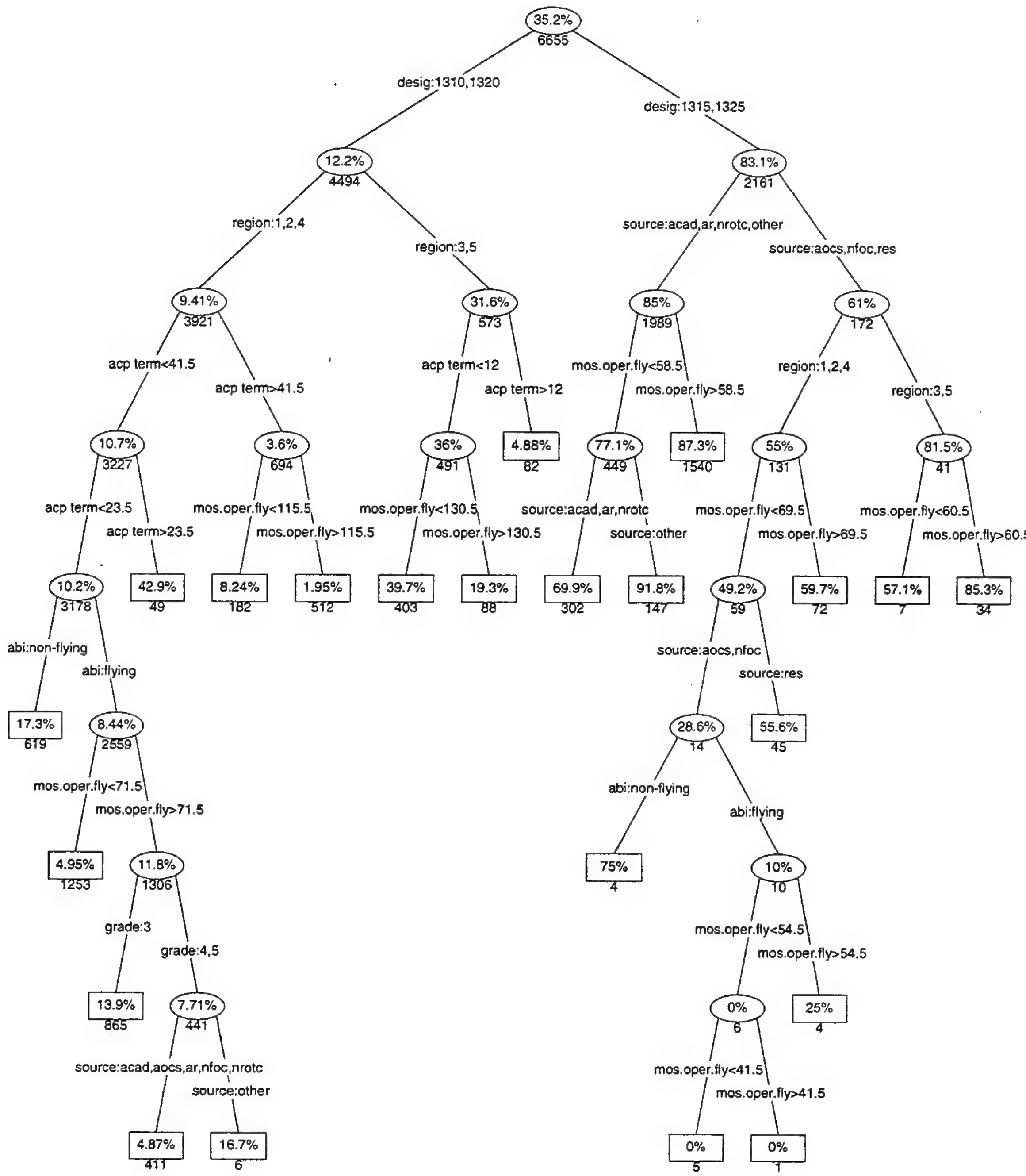


Figure 5: Classification Tree Model

Looking at the Tree model as two distinct parts, split at node number one, the left branch predicts, quite accurately, on aviators with designator 1310 and 1320, whereas the right branch of the model does a poor job of predicting on aviators with designator 1315 and 1325. In other words, it is possible to more accurately predict the retention of Regular Navy unrestricted line pilots and NFOs, than Naval Reserve unrestricted line pilots and NFOs. Table 11 and Table 12 illustrate the accuracy of each node of the Tree Model. Some of the errors in Table 11 are exaggerated by the small population sizes of the leaves. Five of the leaves have populations of fewer than ten aviators each. With the exception of nodes 271 and 17 the left branch of the tree predicts to within four percent of the actual probability of leaving for the remaining 50 percent of the data set. The small size of nodes 271 and 17 makes these predictions prone to error. The column "Predicted (prob. leave)" was computed by performing the S-Plus function *predict.tree* on the held-out data.

Table 11: Predicted Probability Coefficients from Tree Model, Designators 1315 and 1325

Node number	Size	Tree Model (prob. leave)	Predicted (prob. leave)	Difference
24	302	0.1364	.6987	0.5623
25	147	0.6250	.9184	0.2934
13	1540	0.6398	.8727	0.2329
112	4	0.8529	.7500	0.1029
452	5	0.4286	.0000	0.4286
453	1	0.8784	.0000	0.8784
227	4	0.4660	.2500	0.2160
57	45	0.8989	.5556	0.3433
29	72	0.8848	.5972	0.2876
30	7	0.8586	.5714	0.2872
31	34	0.9789	.8529	0.1260

Table 12: Predicted Probability Coefficients from Tree Model, Designators 1310 and 1320

Node number	Size	Tree (prob. leave)	Predicted (prob. leave)	Difference
32	619	0.1447	.1729	0.0282
66	1253	0.0469	.0495	0.0026
134	865	0.1420	.1387	0.0033
270	411	0.0499	.0487	0.0012
271	6	0.4167	.1667	0.2500
17	49	0.4091	.5417	0.1326
18	182	0.1042	.0824	0.0218
19	512	0.0146	.0195	0.0049
20	403	0.4185	.3970	0.0215
21	88	0.1905	.1932	0.0027
11	82	0.0132	.0488	0.0356

The primary split of the classification tree on designations 1310 and 1320 versus designations 1315 and 1325 indicates a fundamental difference in attrition behavior of Regular Navy unrestricted line pilots and NFOs and Reserve unrestricted line pilots and NFOs. The tree model incorporates the interactions of region, ACP term, source, months of operational flying, ABI, and grade and shows a fundamental difference between Regular and Reserve aviators. The fact that the branch with Reserve officers does a poor job of predicting attrition behavior most likely represents an absence of one or more explanatory variables in the data.

E. PREDICTIVE POWER

As a final check of the goodness of fit of each model, a test of its predictive ability was made, for the remaining 50 percent of the sample. Each case was classified in relation to its predicted probability compared with a threshold value. If the probability was greater than or equal to the threshold, it was classified as an attrite. If it was less than

the threshold, it was classified as a stay. The predicted turnover was then cross-tabulated with the actual turnover. This procedure was repeated in order to determine the optimal threshold for minimizing misclassifications.

These thresholds were used to evaluate the predictive power of the respective models on the remaining 50 percent of the data. The logistic model and classification tree models make two kinds of errors. The models incorrectly predict that some aviators who actually leave will stay, and that some aviators who actually leave will stay. These "type I" and "type II" errors are considered to be equally costly. The naive model assumes that all aviators will remain in the Navy and has an error rate of 35.24 percent. A summary of the prediction results is depicted in Table 13. The column "errors" gives the total type I and type II errors resulting from using the models to predict fitted values for the remaining 50 percent of the data set. "Gain" represents the difference in correct predictions using each model versus the naïve model. The Logistic model resulted in a 23.94 percent increase in the number of correct predictions and the Tree model resulted in a 27.98 percent increase in the number of correct predictions.

Table 13: Model Prediction Summary

Model	Threshold Probability	Size of Test Set	Actual Attrites	Number of Correct Predictions	Errors	Gain	% Gain
Naïve		6655	2345	4310	2345		
Logistic	0.417	6655	2345	5342	1313	1032	23.94
Tree	0.625	6655	2345	5503	1152	1193	27.68

V. DISCUSSION

A. SUMMARY

This thesis analyzed factors that influenced the retention of mid-career Naval aviators serving between 1990 and 1996. Data for this study was drawn from the OMF maintained by the BUPERS. The OMF includes detailed information on the service member's current assignment, aviation related information, dependency data, initial entry information, personal demographic information, promotion information, separation codes, service school information, and specialty skill codes. Selection of independent variables was based on the results of previous retention studies and the findings of the N-88 working group. Restrictions imposed were: Naval aviators (pilots and NFOs), serving in the Unrestricted Line (no Warrant Officers or Limited Duty Officers) paygrades O-3 to O-5, with less than 20 years service. A logistic regression model was used to determine significant variables and to analyze their relative importance in explaining differences in the retention behavior of these officers. A classification tree was built using the same data to compare and contrast with the results of the logistic regression model.

The factors found to significantly influence the 6655 sample members' decisions to leave active duty included: ABI, source code, ACP annual amount (logistic model only), ACP term (tree model only), career months of operational flight time, primary designation, grade, and geographic location of last duty station.

B. CONCLUSIONS

This research indicated that several factors were significant in predicting naval aviator retention. From the Logistic model, variables which increased the probability of an aviator leaving the navy included: designations 1315, 1325 and 1310; ABIs reflecting non-flying billets; grade O-3, geographic regions 1, 3, and 5; source codes ACAD, AOCS, NFOC, Reserve, and other; and months of operational flying. The higher rate of attrition for pilots and NFOs in the Naval Reserve is due to the requirement for reservists to "augment" into the Regular Navy in order to continue serving past their initial obligated service. Regular Pilots and NFOs in non-flying billets may be more likely to leave the Navy because of a general dissatisfaction aviators feel for jobs where they are not exercising their warfighting skills.

Lieutenants have the highest attrition rate of all grades because they have just completed their period of initial obligated service and this is their first opportunity to voluntarily separate from the Navy. There is also a natural tapering effect of the rank structure. There are fewer billets for higher-ranking officers than for junior officers so there is a natural attrition. Geographic regions 3 and 5, north central U.S. and overseas respectively, are the duty stations most removed from the major metropolitan areas of the country and are considered least desirable by many Naval aviators. The difficulty for spouses obtaining employment in these geographically separated regions may also contribute to higher attrition for officers stationed there.

Officers with source codes representing qualification for appointment under the NROTC program or as Augment Reserves had an increased probability of retention

compared to other sources of appointment. The effect for Augment Reserves was not particularly strong. High total months of operational flying actually increased the probability of attrition slightly, but it was a very weak effect.

Of particular interest was the accuracy with which the classification tree model was able to predict the retention of aviators serving as unrestricted line officers in the Regular Navy. For Regular officers, geographic regions 3 and 5, ACP terms less that 12 months, ABIs reflecting a non-flying billet, and grade O-3 increased attrition. The length of the ACP contract was a new variable; otherwise all the effects discovered in the classification tree appeared in the logistic model. By law the shortest aviation bonus contract is 12 months long; therefore an ACP term less than 12 months translates into no aviation bonus contract. Aviators without a bonus contract and who have fulfilled their minimum service obligation are free to leave the Navy at any time and would be much more likely to attrite than those still under contract.

These findings compare well with previous research. Officers from NROTC backgrounds were retained at higher levels than those from all other sources. This result mirrors research by Singley (1986) who found that tactical plots accessed from the Reserve Officers Training Corps (Regular) had the greatest probability of retention and Zinner (1997) who states that officers commissioned through the United States Naval Academy and Reserve Officers Training Corps programs had an increased probability of retention as compared to other sources. The impact of duty station location on retention agrees with findings of Kocher and Thomas (1994). The impact of flying versus non-flying billets generally falls into the category of job satisfaction. Aviators are less

satisfied with non-flying billets and this translates into increased attrition. These findings are supported by the bulk of the studies referenced in sections II.B and II.C.

Regardless of the model selected, both outperform the current CCR methodology. The 1996 $CCR_{6\text{-}11}$, shown in Table 14, calculated from the same sample used to build both models, is 57.3 percent. This percentage represents the "probability that a pilot with 6 years of service will still be in the Navy at 11 years of service (Cymrot, 1988)." As discussed earlier the CCR is overly sensitive to small changes in the officer inventory and incorporates none of the information used in the logistic or classification tree models. The CCR does not reflect the fundamental differences in behavior between Regular and Reserve aviators and it is not able to differentiate between subsets of the population.

Table 14: Calculation of the $CCR_{6\text{-}11}$ for 1996

Years of Service	Year Group	Beginning Inventory	Ending Inventory	Continuation Rate
6	90	583	575	98.6
7	89	545	522	95.8
8	88	347	291	83.9
9	87	339	275	81.8
10	86	269	247	91.8
11	85	239	232	97.1
$CCR_{6\text{-}11}$				57.28%

Source: Author

C. POLICY IMPLICATIONS

While no model can accurately predict the highly personal retention decision of a single aviator, these models highlight several areas which, when used examine the behavior of groups of aviators, may have significant impact on future policy decisions. Specifically, attention needs to be paid to the negative effect that remote duty stations and non-flying billets have on retention. Use of existing incentives such as ACP and ACIP targeted at aviators in situations shown to negatively affect retention may be used to reduce attrition in these areas.

Both logistic and classification tree models identified duty stations in the north central U.S. and OCONUS as increasing attrition. Planners need to evaluate the perceived hardships associated with duty in these areas and either increase incentives or improve the quality of life of service members stationed there. The same is true for assignment to non-flying billets. Decreasing the overall number of non-flying billets, filling these billets with non-aviation designated officers, or shortening the length of non-flying tours are all actions that may decrease the attrition rate. Both models also indicate that Lieutenants (grade O-3) are the group most likely to attrite. Planners should target incentives to this group in order to decrease attrition.

D. RECOMMENDATIONS

Future research in the area of military retention needs to incorporate the influence of the economy on attrition. The difficulties found in incorporating economic variables, job satisfaction and alternative employment considerations into the models should not deter future research in this area. A comprehensive exit survey of pilots and NFOs

combined with the data resident in the OMF may illuminate factors not previously considered. Previous studies incorporating the influence of alternative employment opportunities, job satisfaction and recent economic conditions on the retention decision have shown promising results (Ilgen & Klein, 1988; Steers & Mowday, 1981; Cotton & Tuttle, 1986; O'Reilly, 1991; Zinner, 1997).

Finally, comprehensive data on deployed time needs to be reported for all navy personnel in order better to support analysis of quality of life issues such as operational tempo on retention. Existing data in the OMF which is supposed to track the cumulative number of months a unit is deployed away from its permanent duty station does not sufficiently reflect the operational tempo being felt by many Naval aviators. Only periods in excess of 30 days are included, and type training, overhauls, and refresher training are excluded. These constraints and incomplete data precluded its use in this study. Specifically, detailed information recording days away from homeport or duty station, for any reason, should be maintained in the OMF database for all personnel.

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APPENDIX A. BUPERS OMF DATA

Variable / Long Name	Description
ABI - Aviation Billet Indicator	Indicates the operational flying status of the billet in which an officer is currently serving.
ASI - Aviation Status Indicator	Indicates an aviation officer's Aviation Career Incentive Pay (ACIP) entitlement status.
MOS OPER FLY - Months of Operational Flying	Indicates the number of months an officer has served in an operational flying billet. This number will be incremented by one for each month an officer continues to serve in an operational flying billet. This is the total number of months that an aviator has acquired operational flying during his/her aviation service.
PRIAERDES - Primary Aeronautical Designation	Identifies an officer's aviation specialty.
ACP STOP DT - Aviation Officer Continuation Pay Stop Date	YYMMDD which indicates when an officer completed or will complete additional obligated service as a result of an Aviation Flight Bonus contract.
ACO Term – ACP Contract Term	Indicates the number of months of the contract term.
ACP ANN AMT – ACP Annual Amount	Indicates the annual entitlement in hundreds of dollars for the contract.
DEPN PRI - Primary Dependency Code	Reflects the number and type of an officer's primary family members who are related to the officer. (Lawful spouse, unmarried dependent children under the age of 21 or is incapable of self-support.)
DEPN SEC - Secondary Dependency Code	Identifies the dependency of a parent upon an officer.
DOB - Date of Birth	YYMMDD which indicates the year, month and day of an officer's birth.
ETHNIC - Ethnic Group Code	Describes segments of the population that possess common characteristics and a cultural heritage significantly different from that of the general population.
RACE - Race Code	Identifies an officer's race.
SEX - Sex Code	Identifies an officer as male or female.

Variable / Long Name	Description
SOURCE - Current Source Code	Indicates the program under which an officer qualified for original appointment.
DOR - Date of Rank	YYMMDD of an officer's date of rank in his/her current grade.
PROM STAT - Promotion Status	Indicates an officer's selection or failure of selection for promotion to the next grade higher than his/her current grade. Also indicates fiscal year of selection or failure.
GRADE - Current Grade	Identifies the grade in which an officer is presently serving unless he/she is serving in a Spot Promotion Grade.
DESIG - Designator	Identifies the category in which an officer is appointed and/or designated and the status of the officer within the category.
YR GRP - Precedence Year Group	Reflects the present precedence of an officer for promotional purposes. In most cases the year group generally corresponds to the fiscal year in which he/she was commissioned to Ensign.
AQD1 – First Additional Qualification Designation	Identifies the attainment of skills and knowledge in addition to those identified by the officer's Designator.
AQD2 – Second Additional Qualification Designation	Identifies the attainment of skills and knowledge in addition to those identified by the officer's Designator.
AQD3 - Third Additional Qualification Designation	Identifies the attainment of skills and knowledge in addition to those identified by the officer's Designator.
REGION – Geographic Location	Identifies the geographic location of the Activity at which an officer is stationed.
Leaves – Year Officer Leaves Navy	YY of date officer leaves Navy.

APPENDIX B. FEDERAL RESERVE BANK ECONOMIC DATA

Variable	Name	Description
Transemploy	Transportation Industry Employment Rate	Monthly totals of U.S. employees in the Transportation & Public Utilities Industry (Seasonally adjusted, thousands of employees)
Unemployrate	Unemployment Rate	Civilian Unemployment Rate (Seasonally adjusted, %)
Cpi	Consumer Price Index	Consumer Price Index for all urban comsumers: All Items (Not seasonally adjusted)
Cpi.sa	Seasonally adjusted Consumer Price Index	Consumer Price Index for all urban comsumers: All Items (Seasonally adjusted)
Prime	Prime Lending Rate	Bank prime loan rate on short-term business loans, averages of daily figures (%)
Income	Average Income	Personal Income (Seasonally adjusted, Billions of $)
House starts	New Housing Starts	Total Housing Starts (Seasonally adjusted, thousands of units)
Sp500	S&P 500 Index	S&P 500 Total Return: Daily Dividend Reinvestments

APPENDIX C. DESCRIPTIVE STATISTICS

Table 1: Categorical Variable Descriptive Statistics

Variable	Count	Percentage
Aviation billet Indicator		
Flying	5276	79.28%
Non-flying	1379	20.72%
Commissioning Source		
USNA	1267	19.04%
AOCS	731	10.98%
AR	1680	25.24%
NFOC	385	5.79%
NROTC	1379	20.72%
RES	894	13.43%
Other	319	4.79%
Dependents		
No dependents	1569	23.58%
Spouse	1808	27.17%
Spouse and one child	1193	17.93%
Spouse and two children	1296	19.47%
Spouse and three children	414	6.22%
Spouse and more than three children	117	1.76%
Military Spouse	139	2.09%
Military Spouse and one or more children	49	0.74%
No Spouse and one or more children	70	1.05%
Designation		
1310	2861	42.99%
1315	1494	22.45%
1320	1575	23.67%
1325	725	10.89%
Grade		
O-3	4985	74.91%
O-4	1167	17.54%
O-5	503	7.56%

Table 1: Categorical Variable Descriptive Statistics (Cont'd.)

Variable	Count	Percentage
Race		
C - White (Caucasian)	6313	94.86%
N - Black (Negroid or African)	153	2.30%
X - Other	189	2.84%
Region		
1 - Northeast	326	4.90%
2 - South	3162	47.51%
3 - Northcentral	105	1.58%
4 - West	2065	31.03%
5 - OCONUS	997	14.98%
Sex		
Male	6460	97.07%
Female	195	2.93%
Year Group		
73 to 79	249	3.74%
80	189	2.84%
81	220	3.31%
82	300	4.51%
83	440	6.61%
84	403	6.06%
85	600	9.02%
86	666	10.01%
87	577	8.67%
88	450	6.76%
89	640	9.62%
90	598	8.99%
91	472	7.09%
92	509	7.65%
93	324	4.87%

Table 2: Continuous Variable Descriptive Statistics

Variable	Min	1st Quartile	Median	Mean	3rd Quartile	Max
ACOP annual amount	0	0	0	12.42	0	120
ACOP term in months	0	0	0	10.49	0	97
Months of Operational Flying	0	62	81	87.93	107.5	235

APPENDIX D. TREE MODEL OUTPUT

This appendix contains the S-Plus output for the classification tree pruned to 22 terminal nodes. Each row contains the node number, the node split, the number of observations in the node, the deviance at the node, the fitted value (TRUE for attrite, FALSE for non-attrite) and the estimated probabilities for of the observations in that node not leaving, and leaving the Navy .

```
node), split, n, deviance, yval, (yprob)
      * denotes terminal node

  1) root 6655 8649.00 FALSE ( 0.64610 0.35390 )
    2) desig:1310,1320 4436 3238.00 FALSE ( 0.88100 0.11900 )
      4) region:1,2,4 3877 2323.00 FALSE ( 0.91130 0.08873 )
       8) acp.term<41.5 3206 2069.00 FALSE ( 0.90110 0.09888 )
        16) acp.term<23.5 3162 1979.00 FALSE ( 0.90540 0.09456 )
          32) abi:FALSE 615  508.50 FALSE ( 0.85530 0.14470 ) *
          33) abi:TRUE 2547 1450.00 FALSE ( 0.91760 0.08245 )
            66) mos.oper.fly<71.5 1237  468.20 FALSE ( 0.95310 0.04689 ) *
            67) mos.oper.fly>71.5 1310  940.40 FALSE ( 0.88400 0.11600 )
             134) grade:3 845  690.50 FALSE ( 0.85800 0.14200 ) *
             135) grade:4,5 465  233.00 FALSE ( 0.93120 0.06882 )
               270) source.fac:acad,aocs,ar,nfoc,nrotc 441  174.80 FALSE
                                                    (0.95010 0.04989 ) *
               271) source.fac:other 24   32.60 FALSE ( 0.58330 0.41670 ) *
        17) acp.term>23.5 44   59.53 FALSE ( 0.59090 0.40910 ) *
       9) acp.term>41.5 671  226.40 FALSE ( 0.95980 0.04024 )
        18) mos.oper.fly<115.5 192  128.30 FALSE ( 0.89580 0.10420 ) *
        19) mos.oper.fly>115.5 479   73.06 FALSE ( 0.98540 0.01461 ) *
      5) region:3,5 559  708.30 FALSE ( 0.67080 0.32920 )
       10) acp.term<12 483  641.00 FALSE ( 0.62110 0.37890 )
         20) mos.oper.fly<130.5 399  542.50 FALSE ( 0.58150 0.41850 ) *
         21) mos.oper.fly>130.5 84   81.80 FALSE ( 0.80950 0.19050 ) *
       11) acp.term>12 76   10.65 FALSE ( 0.98680 0.01316 ) *
    3) desig:1315,1325 2219 2069.00 TRUE ( 0.17670 0.82330 )
      6) source.fac:acad,ar,nrotc,other 309  427.20 TRUE ( 0.46930 0.53070 )
       12) mos.oper.fly<58.5 98  119.00 FALSE ( 0.70410 0.29590 )
         24) source.fac:acad,ar,nrotc 66   52.58 FALSE ( 0.86360 0.13640 ) *
         25) source.fac:other 32   42.34 TRUE ( 0.37500 0.62500 ) *
       13) mos.oper.fly>58.5 211  275.80 TRUE ( 0.36020 0.63980 ) *
      7) source.fac:aocs,nfoc,res 1910 1471.00 TRUE ( 0.12930 0.87070 )
       14) region:1,2,4 1431 1245.00 TRUE ( 0.15720 0.84280 )
         28) mos.oper.fly<69.5 502  547.50 TRUE ( 0.23510 0.76490 )
           56) source.fac:aocs,nfoc 314  391.40 TRUE ( 0.31530 0.68470 )
            112) abi:FALSE 102   85.18 TRUE ( 0.14710 0.85290 ) *
            113) abi:TRUE 212  284.70 TRUE ( 0.39620 0.60380 )
              226) mos.oper.fly<54.5 109  126.30 TRUE ( 0.26610 0.73390 )
                452) mos.oper.fly<41.5 35   47.80 FALSE ( 0.57140 0.42860 ) *
                453) mos.oper.fly>41.5 74   54.78 TRUE ( 0.12160 0.87840 ) *
              227) mos.oper.fly>54.5 103  142.30 FALSE ( 0.53400 0.46600 ) *
           57) source.fac:res 188  123.10 TRUE ( 0.10110 0.89890 ) *
         29) mos.oper.fly>69.5 929  663.70 TRUE ( 0.11520 0.88480 ) *
       15) region:3,5 479  178.50 TRUE ( 0.04593 0.95410 )
         30) mos.oper.fly<60.5 99   80.69 TRUE ( 0.14140 0.85860 ) *
         31) mos.oper.fly>60.5 380   77.60 TRUE ( 0.02105 0.97890 ) *
```

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   Monterey, CA 93943-5002